RESEARCH CONCERNING THE INFLUENCE OF CLIMATE CONDITION OVER THE PHENOLOGICAL STAGES AT WALNUT TREE (*JUGLANS REGIA* L.)

CERCETĂRI PRIVIND INFLUENŢA CONDIŢIILOR CLIMATICE ASUPRA STADIILOR FENOLOGICE LA NUC (*JUGLANS REGIA* L.)

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Abstract. *Carrying out the phenological stages of vegetation and fruit set in walnut is determined by the cumulative action of daily average temperatures exceeding 10°C, value considered as biological limit of walnut cultivars. In climate conditions from last few years, some changes was observed about values of the sum degree of active temperature necessary onset the phenological stages of walnut tree. The research was conducted during 2009-2013 by six walnut cultivars with different fruit maturation period, existing in the experimental plot from Research Station for Fruit Growing Iaşi, Romania. The paper aims to determine the active thermal balance needed to carry out the fruiting phenophases and comparing the results with data cited in the literature.*
Key words*: temperature, phenology, cultivars, flowering, fruiting, walnut tree.*

Rezumat. *Desfăşurarea fenofazelor de vegetaţie şi fructificare la nuc este determinată de acţiunea cumulată a temperaturilor medii zilnice ce depăşesc valoarea de 10°C, considerată prag biologic la specia nuc. În condiţiile climatice din ultimii ani, s-a observat o schimbare a sumei gradelor de temperatură activă necesară declanşării stadiilor fenologice la nuc. Cercetările au fost efectuate pe perioada 2009-2013 la şase soiuri de nuc cu perioada de maturare a fructului diferită, existente în lotul experimental din cadrul Staţiunii de Cercetare-Dezvoltare pentru Pomicultură, Iaşi. Lucrarea are ca obiectiv determinarea bilanţului termic activ necesar desfăşurării fenofazelor de fructificare şi compararea rezultatelor cu datele citate în literatură.*
Cuvinte cheie: *temperatură, fenologie, soiuri, înflorire, fructificare, nuc.*

INTRODUCTION

The walnut tree is a species with economic importance due to nutritional, technological and commercial aspects of the fruits (Botu et al., 2001). In Romania, area cultivated with walnut is about 1,500 ha with an average production of 20 t / ha and total production of 30,500 tonnes in 2012 (FAOSTAT). In the last five years have seen a decrease in the cultivated area with walnut trees but still a demand of planting material from the nursery.

Study phenophases in walnut is important to determine the optimal conditions during flowering to ensure the fruit onset. Changes current climate conditions influences the phenological stages of plants (Inouye, 2008; Inouye et al.,

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2003) but there are just a few recent studies about fruit trees species (Tooke and Battey, 2010; Chmielewski et al., 2004). Previous research have shown that the start of vegetation and fruiting phenophases in walnut tree are determined by the action of daily average temperatures that exceed the value of 10°C and have a direct influence on plant flowering (Cociu et al., 2007; Istrate, 2007).

Global climate change affects indications used by plants to start flowering (Sparks et al., 2000; Sîrbu et al., 2013) bringing the phenophases to advance with 4-7 days per degree Celsius of high temperature (Darbyshire et al., 2012).

This paper aims to determining the active thermal balance necessary to blossoming of female flowers phenophases of walnut cultivars in terms of climate change and comparing the results with data from literature.

MATERIAL AND METHOD

For experimentation, six walnut cultivars were studied in period 2009-2013, which were in existence at the collection of the experimental plot, which can be found at the Fruit Growing Research Station, Iaşi - Romania. Phenological data were determined through the INRA system cited by Botu et al., 2001: Af_2- cataphylles depart and fall, the mixed buds are still closed in other less developed semi-membranous cataphylles; Ef- occurrence of female flowers. The climatic data were recorded with the AgroExpert system by the station located on the perimeter of the experimental plot of the Fruit Growing Research Station, Iaşi - Romania.

The active thermal balance (Σt°a) is provided by the sum of average daily temperature grades, which exceeds the biological limit characteristic to the walnut tree, considered to be 10°C (Cociu et al., 2007).

Σt°a = ΣT atd – BL, in which:

ΣT atd = sum of average temperature of days between two subsequent phenological stages;

BL = the biological limit of fruit tree species (Istrate, 2007).

The statistical interpretation of experimental data. The statistical analysis was performed with the XLSTAT programme. The differences between cultivars was determined by the Duncan test ($p \leq 0.05$), coefficient of variation and the Pearson correlation coefficient has been calculated between the variables measured ($p \leq 0.05$).

RESULTS AND DISCUSSIONS

During 2009 - 2013 it has been observed a great variability of the number of days and the sum of active degrees of temperature between the phenological stages according to the walnut tree cultivar and climatic year. Therefore, the period from the swelling of the mixed buds until the beginning blossoming of female flowers, the studied cultivars showed large variations in vegetation period and the active thermal balance (table 1).

During the study values ranged between six days at *Velniţa* (2012 year conditions) and 20 days at *Sf. Sava* (2010 year conditions) and *Geoagiu 65* cultivar (2013 year conditions).

Table 1

Number days and sum of temperature degrees between stages Af_2-Ef on six walnut cultivars (2009-2013)

Cultivar	Number days and sum of temperature degrees between stages Af2-Ef*									
	2009		2010		2011		2012		2013	
	D	∑T	D	∑T	D	∑T	D	∑T	D	∑T
Miroslava	13	157	14	160,4	13	187,4	19	226,4	10	110,4
Velniţa	13	163,9	12	139,3	16	216,1	6	88,8	10	110,4
Ezăreni	15	196	14	162,2	9	129,1	9	154,7	13	159,8
Sf. Sava	14	168	20	234,9	19	226,2	19	234,3	17	196
Geoagiu 65	15	196	16	182	16	219	19	270,3	20	276,1
Germisara	14	168	17	193,4	16	219	19	289	16	208,3
Average	**14**	**174,8**	**15,5**	**178,7**	**14,8**	**199,5**	**15,2**	**210,6**	**14,3**	**176,8**
Minim	**13**	**157**	**12**	**160,4**	**9**	**129,1**	**6**	**88,8**	**10**	**110,4**
Maxim	**15**	**196**	**20**	**234,9**	**16**	**219**	**19**	**289**	**20**	**276,1**
STDEV	**0,9**	**16,9**	**2,8**	**33,3**	**3,4**	**37,0**	**6,0**	**75,5**	**4,0**	**63,8**
COVAR S%	**6,4**	**9,7**	**18,1**	**18,6**	**23,1**	**18,6**	**39,7**	**35,8**	**28,1**	**36,1**

* Af_2- Cataphylles depart and fall, the mixed buds are still closed in other less developed semi-membranous cataphylles; Ef- Occurrence of female flowers; D- number days; ∑T- sum of temperature degrees; STDEV- standard deviation; COVAR S% - coefficient of variation %

As sum of temperature degrees between stages Af_2 - Ef values ranged between 88.8°C at *Velniţa* (2012 year conditions) and 276.1°C at *Geoagiu 65* (2013 climate conditions).

As average over the studying period the beginning of the mixed buds bursting (Af2) to the occurence of female flowers (Ef) was required an which ranges from 14 days to 15.5 days for different walnut cultivars. The active thermal balance, during this period ranged between 174.8°C (2009) and 210,6°C (2011) (table 1).

High variability in the number of days between this two phenological stages cultivars registered 39.7% in 2012. As the sum of temperatures degrees, the greatest variability was recorded 36.1% in 2013 (table 1).

The coefficient of variation for the number of days during the period studied was between 11.1% (*Germisara*) and 32.6% (*Velniţa*). Coefficient of variation to the amount of degrees of temperature on the period studied was between 13.8% (*St. Sava*) and 34.4% (*Velniţa*) (table 2).

As an average of five years to six cultivars of walnut is required a number of 14.8 days between swelling mixed buds to occurrence of female flowers (Ef stage) but with a variability of 24.3%.

Also, is required an average of 188.1°C with a variability coefficent of 25.9% (table 2).

Table 2

Number days and sum of temperature degrees between stages Af_2-Ef on six walnut cultivars (Average 2009-2013)

Cultivar	Average 2009-2013		Minimum		Maximum		STDEV		COVAR S%	
	D	∑T	D	∑T	D	∑T	D	∑T	D	∑T
Miroslava	13,8	168,3	10	110,4	19	226,4	3,3	42,7	23,7	25,4
Velniţa	11,4	143,7	6	88,8	16	216,1	3,7	49,5	**32,6**	**34,4**
Ezăreni	12	160,4	9	129,1	15	196	2,8	23,9	23,6	14,9
Sf. Sava	17,8	211,9	14	168	20	234,9	2,4	29,2	13,4	**13,8**
Geoagiu 65	17,2	228,7	15	182	20	276,1	2,2	42,8	12,6	18,7
Germisara	16,4	215,5	14	168	19	289	1,8	45,3	**11,1**	21,0
Average	**14,8**	**188,1**	**6**	**88,8**	**20**	**289**				
STDEV	3,6	48,7								
COVAR S%	**24,3**	**25,9**								

Fig. 1 - Stage Ef - Occurrence of female walnut flowers (original)

Correlating the variables studied we observed that *Sf. Sava, Miroslava, Geoagiu 65* and *Germisara* recorded values significant positive of the correlation

coefficient (table 3). At *Ezăreni* number of days between stages Af_2 and Ef was positively correlated with the sum of degrees of temperature recorded in these intervals, but the value of the correlation is not statistically significant.

Table 3

Correlations between the number of days and the sum of degrees of temperature over different phenological years in walnut tree cultivars

Specification	Correlations between variables number of days and sum of degrees of temperature between stages Af_2-Ef
Miroslava	0,9212*
Velniţa	0,9600**
Ezăreni	$0,8169^{ns}$
Sf. Sava	0,9826**
Geoagiu 65	0,9359*
Germisara	0,8910*
Average	**0,9614****
$P_{5\%}$= 0,88	

Correlating the average values of the variables recorded at six walnut cultivars on the five years of study was observed a distinct positive correlation of 0.9614 significant (table 3).

CONCLUSIONS

1. The climate change from recent years have influenced the duration of the phenological phases of different cultivars of walnut tree.

2. Walnut cultivars which have been studied, showed an increasing need for active temperature for the duration of phenophases.

3. In the years with cold spring season, the beginning of the phenological phases at walnut tree is delayed and the phenophases between swelling mixed buds to occurrence of female flowers followed each other in a shorter time.

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